UNION BENT-TUBE BOILERS

UNION IRON WORKS

ERIE, PA.,
U.S.A.

COMMONWEALTH ELECTRIC CO.
417 BROADWAY
ST. PAUL, MINNESOTA

UNION BENT-TUBE BOILERS

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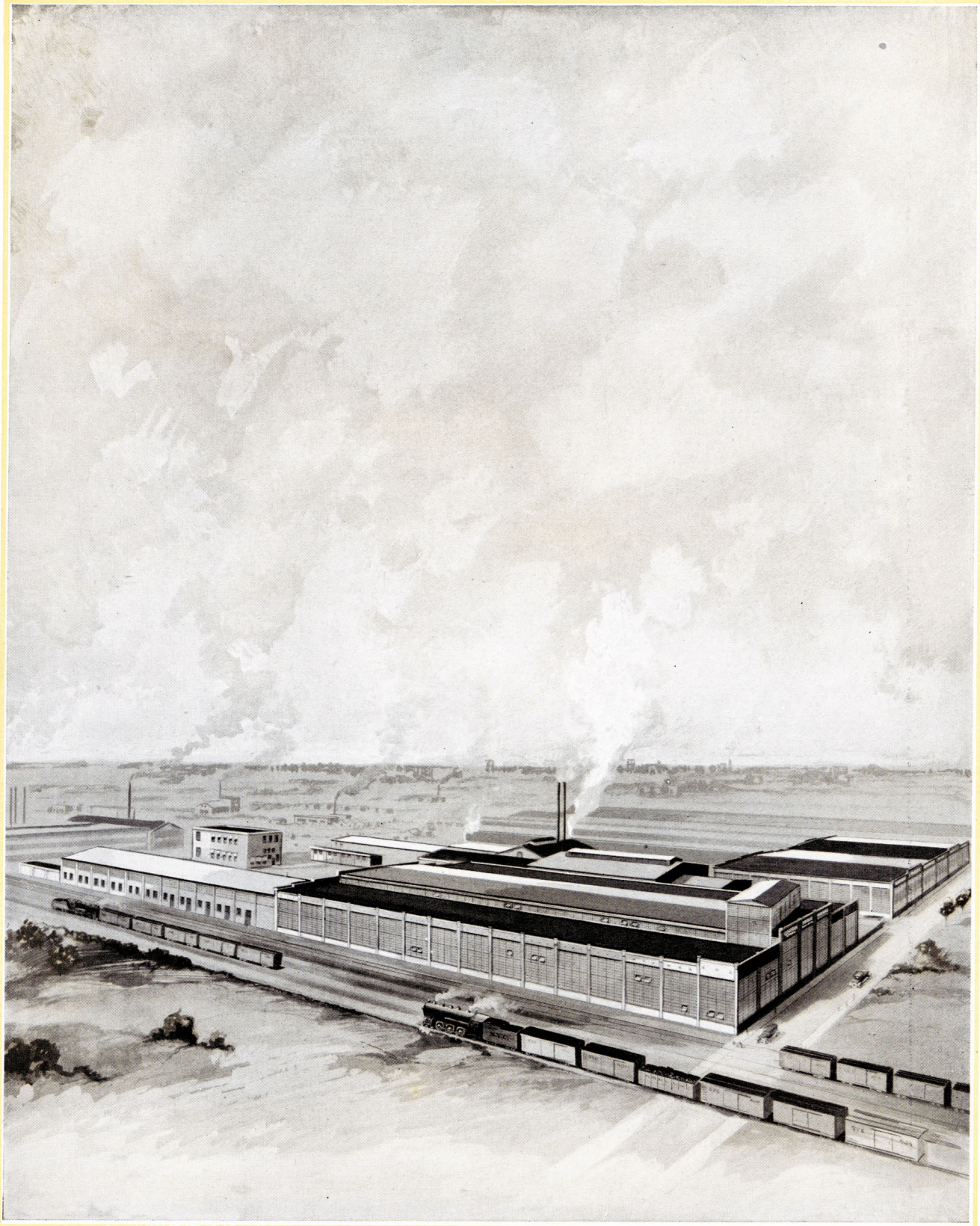
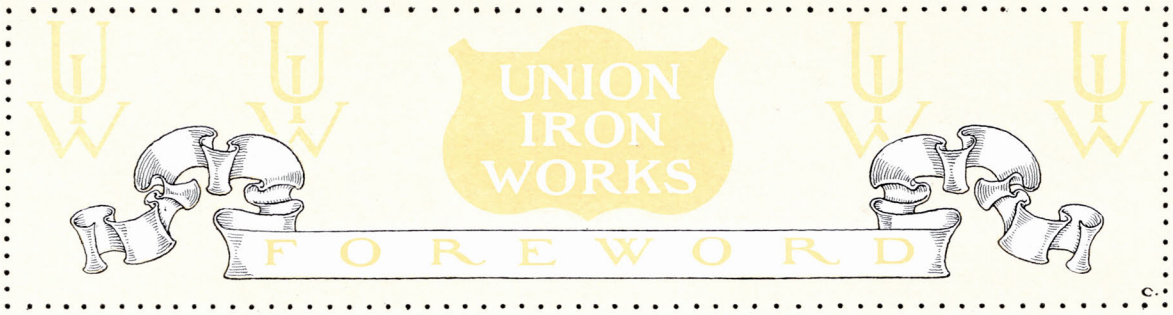
ERIE, PENNSYLVANIA



THE UNION IRON WORKS IS ONE OF THE LARGEST AND MOST COMPLETELY EQUIPPED PLANTS DEVOTED EXCLUSIVELY TO STEEL BOILER MANUFACTURING

Founded in 1890

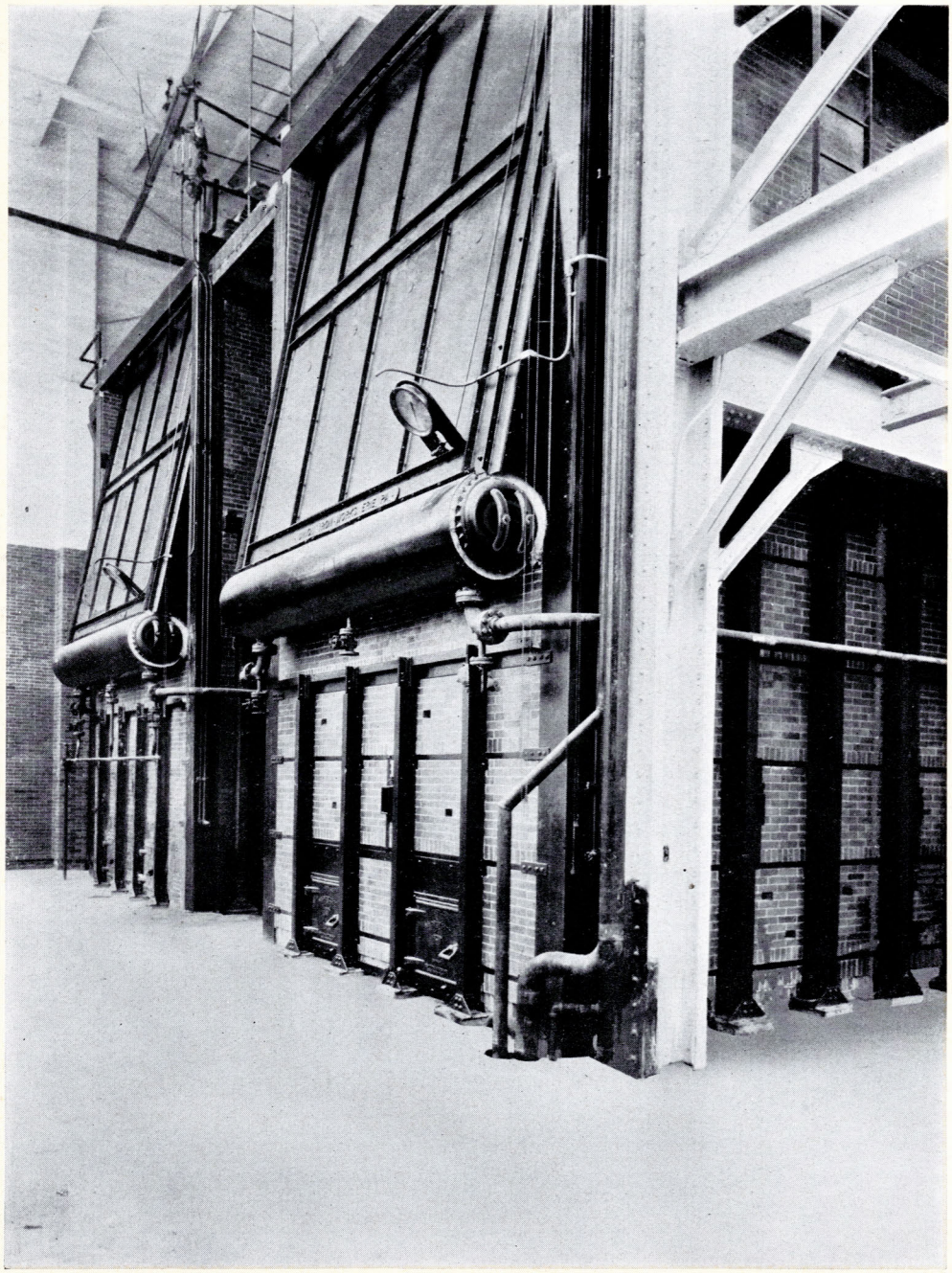


UNION Boilers are the product of more than forty years of manufacturing, engineering and operating experience with high pressure boilers. During this period we have developed modern facilities and special equipment for the manufacture of water tube boilers which represent the highest standards of design and construction.

UNION IRON WORKS builds improved designs of the conventional three drum and four drum bent tube boilers. In addition we have developed an outstanding and far superior bent tube boiler which incorporates in its design a Front Radiant Heat Element.

The N-Type Boilers include the Front Radiant Heat Element and are particularly adapted to greater boiler output and higher efficiencies at peak ratings. This arrangement of heating surfaces has been developed exclusively and patented by the UNION IRON WORKS. The Front Radiant Heat Element, with the boiler tubes forming the front wall of the furnace, exposes more effectively a greater amount of boiler heating surface to the direct radiant heat of the fire. In addition to increasing boiler capacity, the Front Radiant Heat Element forms the front wall of the furnace. The initial cost of the boiler setting as well as furnace maintenance are therefore reduced considerably.

The following pages of this bulletin give a description of UNION Bent Tube Boilers and illustrate typical installations which have been designed for various plant and operating conditions.



TWO 754 H. P. N-A TYPE BOILERS WITH REAR FIRED OIL BURNERS

Pratt & Whitney Aircraft Co., Hartford, Connecticut. Albert Kahn, Inc., Architects and Engineers.

THIS photograph of an N-Type Boiler installation illustrates the replacement of a greater portion of the front wall of the setting by the Front Radiant Heat Element. It also shows the sectional steel panel cover which provides a rigid and pleasing design for the front of the setting. These units have air cooled walls and are oil fired from the rear of the setting through the bridge wall.

DESCRIPTION

MANY years of boiler design and operation have established the fundamental requirements of modern boilers adapted to high capacities consistent with highest efficiencies and reliability.

Developments in boiler firing methods during the last ten years have greatly influenced the design of boilers and settings. Higher rates of combustion have brought out the importance of effective heating surface directly exposed to the radiant heat of the furnace.

Temperature readings thruout a boiler tube bank indicate that by far the greater percentage of water is evaporated in the heating surfaces which are exposed to direct radiant heat action. In the usual boiler this consists of about the first two rows of tubes, which will evaporate many times as much water per square foot of heating surface as the average of the entire tube bank.

This characteristic has led to the application of water walls in the side walls of furnaces, connected by means of headers and circulator tubes to the boiler drums. While this arrangement utilizes the important radiant heat factor, it presents some disadvantages. The restricted connections of headers and circulators from the water wall tubes are insufficient to liberate the steam from these tubes to the drums, due to the high rate of evaporation. The high rate of heat transfer and restricted circulation require the use of condensate returns or evaporated make-up feed water to eliminate all impurities which form scale and cause frequent burning out and failure of water wall tubes. A further disadvantage of water walls placed in the side walls of the furnace is the complicated and expensive construction of both refractory and water walls, which is inherent to that design, making it difficult to maintain and renew these parts.

The UNION IRON WORKS has developed the N Type Boiler which embodies in its design a Front Radiant Heat Element, giving full exposure of boiler heating surfaces to direct radiant heat, without any of the disadvantages of the usual water wall construction. The Front Radiant Heat Element is an integral part of the boiler and consists of three rows of boiler tubes connected to a lower front drum. Baffle tile is placed between the outer and the two inner rows of tubes to provide positive down and up-flow circulation within the unit. The two inner rows of tubes are staggered to present full exposure to the furnace. The lower front drum is connected to the lower rear drum by circulator tubes, maintaining an additional water supply to the lower front drum under all operating conditions. The Front Radiant Heat Element discharges directly into the upper front drum without restriction at all ratings and specially prepared feed water is unnecessary.

The design of the N-Type Boiler which is fully protected by patents owned by the UNION IRON WORKS, practically doubles the effective boiler heating surface exposed to radiant heat.

The staggered arrangement of the two inner rows of tubes in the Radiant Heat Element and their location over the fire

provides a more effective exposure of a greater amount of heating surface to direct radiant heat than can be obtained with side water walls.

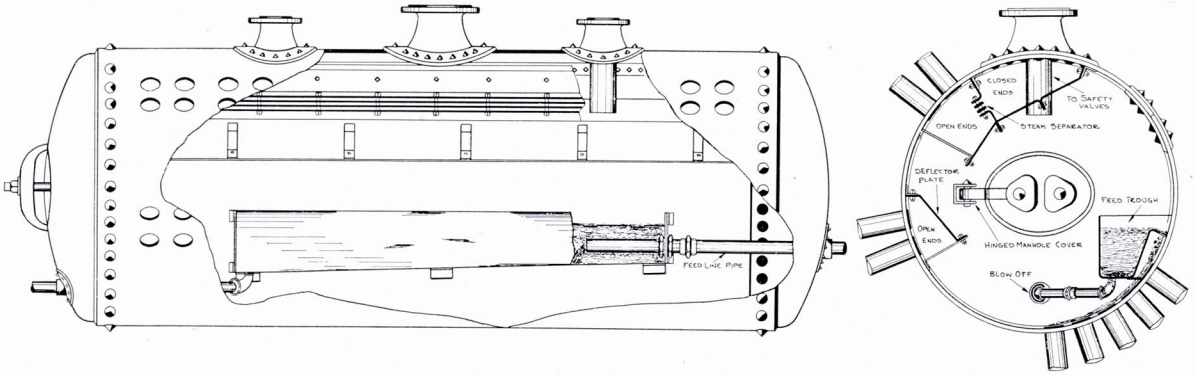
This advantageous distribution of heating surfaces produces higher boiler capacities, increased overall efficiencies at peak ratings and greater ability to meet fluctuating demands for steam. The Radiant Heat Element forms the front wall of the furnace and has the further advantage of eliminating arch construction and reducing front furnace wall refractory work which lowers the cost of the setting and keeps furnace maintenance to a minimum. It has none of the disadvantages of the usual side water walls.

The over-the-fire location of the Front Radiant Heat Element and its high rate of heat absorption results in low exit gas temperatures and reduces the volume of the gases entering the main tube bank of the boiler, producing remarkably low draft losses through N-Type Boilers at all ratings.

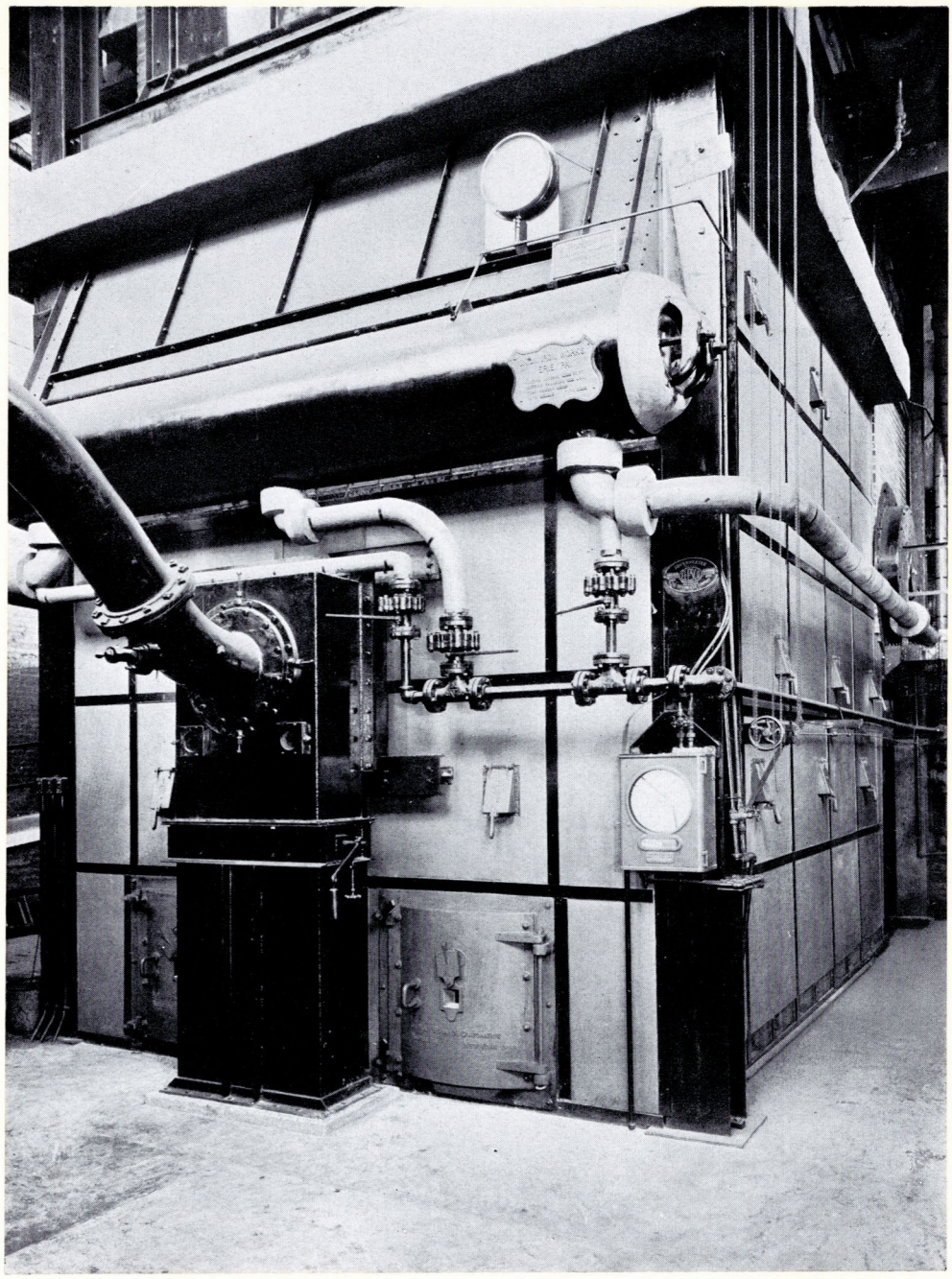
UNION N-Type Boilers are especially suited for industrial plants where at times the entire load must be carried by one boiler. Here high boiler output and reliability are of great importance. Installations in combination with air-cooled side walls and water-cooled bridge walls are delivering 350% continuous rating. Service records from these boilers show excellent heat absorption with unusually low exit gas temperatures and draft losses, at high sustained peak loads. See test data on page 19.

DESIGN

THE Class A, N-Type Boiler has two upper drums and two lower drums. The feed water is taken into the upper rear drum and discharges into a settling trough where sediment and impurities are deposited and removed through a blowoff connection. The overflow from the settling trough then discharges into the drum, over the rear bank of tubes and passes down these tubes into the lower rear drum. The lower drum is also provided with additional blowoff connections. This method of feed water introduction has the definite advantage of not interfering with the circulation by keeping the cooler incoming feed water isolated



DRUM DETAILS



535 H. P. N-A TYPE BOILER FIRED WITH POWDERED COAL

Jamestown Worsted Mills, Jamestown, New York. Harold L. Smith, Cons. Eng.

THIS installation has replaced three boilers with remarkable gains in efficiency and reduction of operating costs. It is fired with powdered coal and designed for 300% continuous rating. The cleanliness and simplicity of the setting are very apparent. Front, side and rear walls are air cooled.

from the water in circulation, and confines the coolest water to the coolest section of the boiler.

All tubes are 3¼ inches in diameter, bent to the same radius. The main bank connecting the lower rear drum and the upper front drum is proportioned in two sections. This grouping of the tubes provides easy entry of the hot gases into the tube bank and maintains a higher rate of circulation. It also permits the use of cross flow baffling through the rear portion of the main bank of tubes. The space between the front and rear sections can be varied to accommodate superheater location.

The lower rear drum is also connected to the lower front drum of the Front Radiant Heat Element by two circulators, one on each side of the setting.

The greatest amount of steam is made in the front section of the main bank and the Front Radiant Heat Element at all ratings. The steam and water rise into the upper front drum without restriction, the steam passing off into the rear drum through two rows of connecting tubes. The two upper drums are spaced wide apart to insure thorough drying of the steam passing through these tubes, the entire length of which is exposed to the hot gases.

Except at high ratings the normal circulation is down the rear section of the main bank and then upwards through the front section. At high ratings the circulation is upwards in all tubes in the main bank, the steam which is generated passing to the rear drum as before described and the water carried to the rear drum through the circulating tubes.

At all ratings the flow in the rear bank of tubes is down to the lower rear drum.

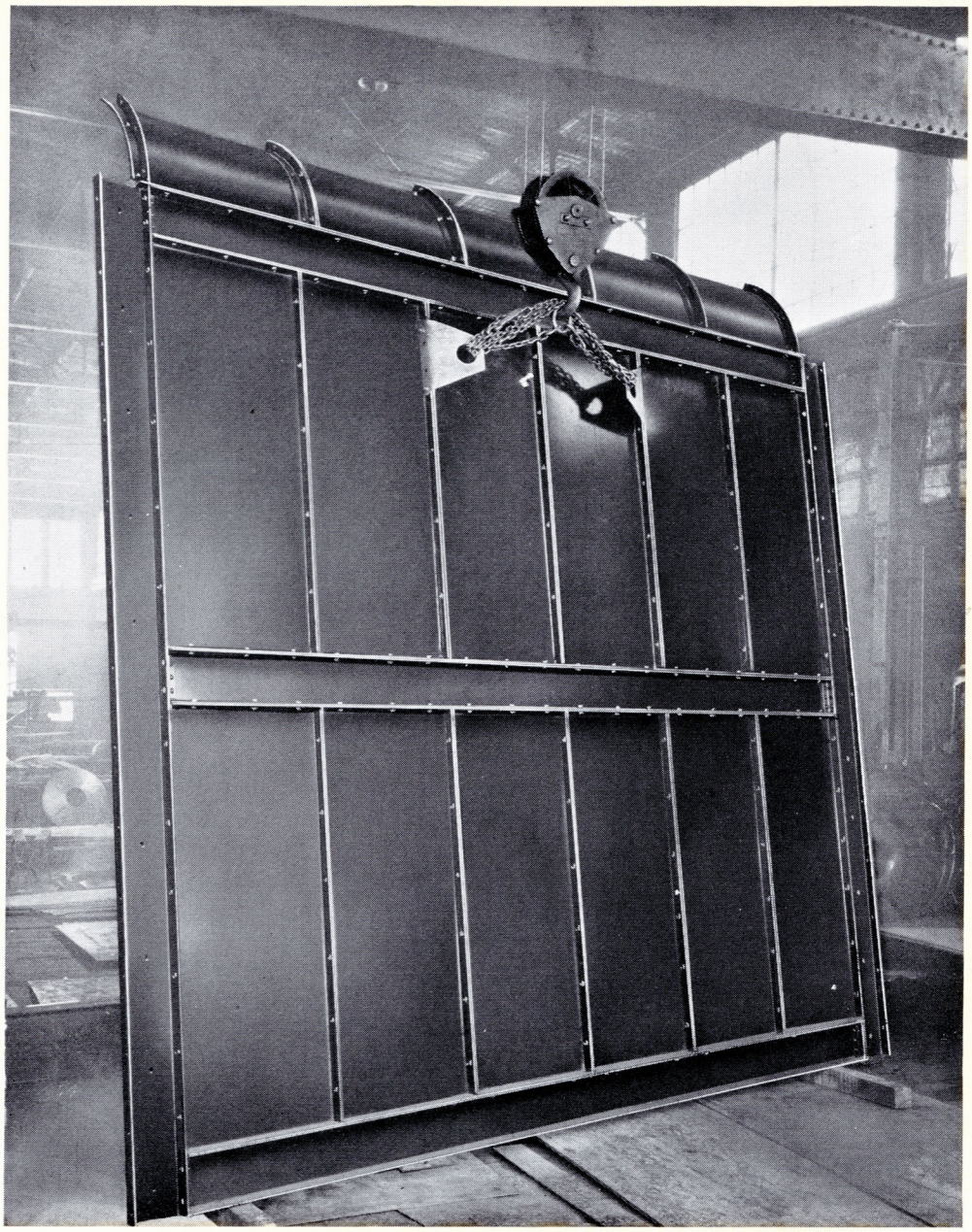
The details of the deflector plates, dry-pipe and feed water trough in the rear drum are shown on page 6.

The Class B, N-Type Boiler has been designed for operating and plant conditions where a large amount of hot water for processing or greater water holding capacity is desired, or where insufficient exhaust steam is available for feed water heating.

The boiler shown on page 18 is generally similar to the Class A, N-Type Boiler, with the addition of an integral economizer section.

Both the Class A and Class B Boilers are baffled for three-pass gas travel so that the hottest gases come in contact with the hottest water. The baffle tile are in all cases easy to get at through access doors in the setting walls. The tile are secured to the tubes by special fasteners which maintain a gas tight baffle.

The gas outlet can be placed at either the top or the rear of the setting.



FRONT RADIANT HEAT ELEMENT COVER

UNION N-Type Boilers are furnished with rigid and well built steel covers for the Front Radiant Heat Element. This cover is built in panel sections, any one of which is easily removable. The cover is secured to the suspension columns to withstand possible plus pressure in the furnace.

CONSTRUCTION

THE drum shells of all UNION Boilers are made in one sheet, the only circumferential seams being at the drum heads. For high pressure work, thicker plate for drum shells is hot rolled. The drums are bored on the inside, on the special machine shown on page 21. A light machine cut is made to insure a tight fit with the drum head which is also finish turned. Caulking is done on the inside of the drum. This construction provides a tight seam for high pressure service.

All plates used in UNION Boilers are bevel planed by special machinery capable of taking a thirty foot continuous cut.

All rivets on the drums are driven by hydraulic pressure. The battery of riveters used for this purpose is shown on page 20. These riveters are served by independent overhead cranes which have sufficient clearance to turn a forty foot shell over the stake. Both manhole heads and blank heads are hydraulically riveted by means of a special head fitted to the top of the riveter. Rivets are heated in a non-oxidizing electric hearth furnace of special design which heats the rivets to a uniform controlled temperature without any scale forming on the body of the rivet.

All nozzles are forged steel and machined to the required curvature of the drum shell, forming a true fit. Manhole covers are pressed steel, with double yokes and hinged to swing inwardly. Gasket surfaces are machine faced.

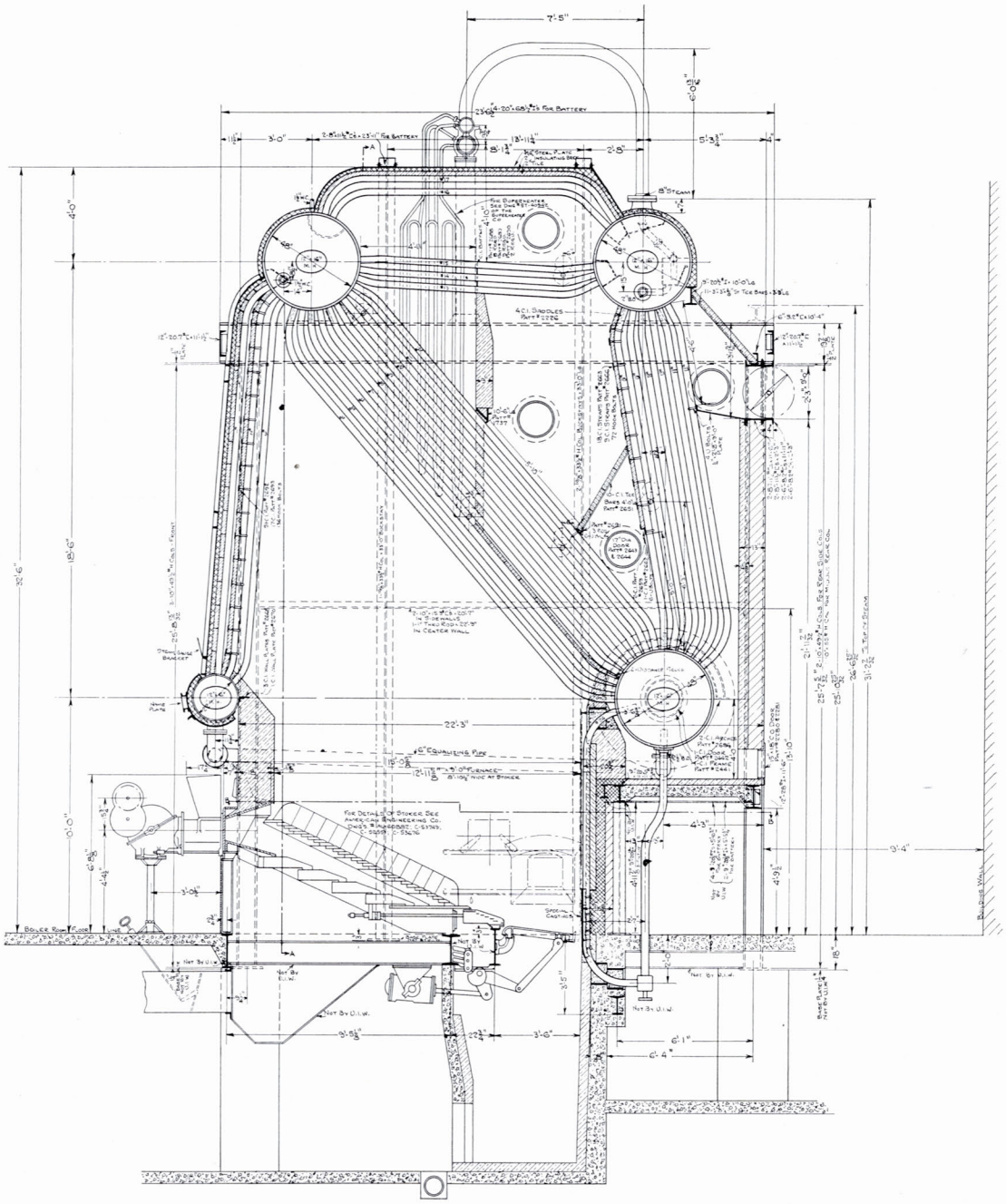
Tube and rivet holes are drilled from solid plate. The large radial drill shown on page 22 is one of several equipped with special cutters of our own design for this purpose. Tube holes are drilled so that the tubes enter the drums radially and are chamfered to prevent cutting of the tubes when they are rolled in.

Fittings and accessories furnished are the best obtainable, to meet the high standard of UNION Boilers.

The suspension members can be designed to meet any particular space requirements or limitations. In all cases the entire weight of the boiler is carried by a rigid suspension arrangement. When sufficient headroom is available the boiler is suspended in "U" bolts passing around the drums. For low headroom conditions the boiler is carried by pressed steel lugs riveted to the drum heads or by saddles on which the drums rest.

All suspension members are fitted together in the shop before shipment is made. This insures proper erection and assembly in the field.

Settings are designed with horizontal reinforcing members. They are arranged to frame in rigidly with the suspension columns, acting as stiffening members in addition to binding the brickwork to prevent buckling.



TWO 506 H. P. N-A TYPE BOILERS BUILT FOR 250 LBS. WORKING PRESSURE

Operated by the Barrett Co., Elizabeth, New Jersey

THESE boilers are of a comparatively high and narrow design for special space conditions. The superheater extends from the top of the boiler between the tubes in the first pass of the main bank. These units have operated at ratings of 350% with ease.

FACILITIES

THE original plant of the UNION IRON WORKS was built in 1890 when the company was incorporated. It was entirely rebuilt in 1922 and is equipped throughout with modern machinery and tools of special design. These facilities have been constantly increased and improved and the UNION IRON WORKS is today one of the best equipped boiler shops in this country.

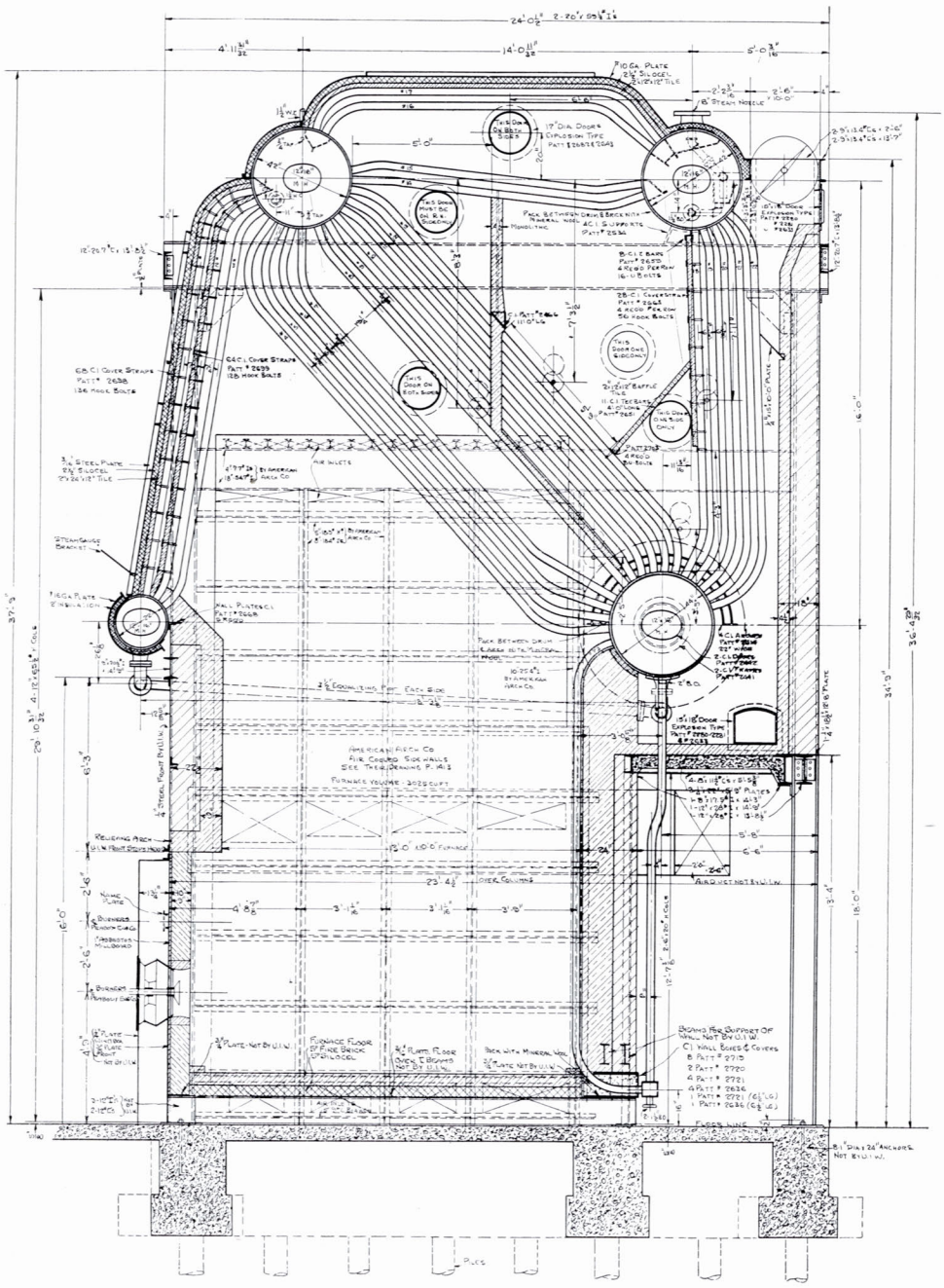
The UNION IRON WORKS has specialized in manufacturing high pressure steel boilers for forty years and has established a national reputation for boilers of advanced design and highest quality.

UNION Water Tube Boilers are built to rigid specifications in longitudinal drum, cross drum, and bent tube types for all commercial working pressures and capacities.

Pages 20 to 23 of this catalogue show interior views of the plant and a portion of the special machinery in use, such as the hydraulic riveter on page 20, which is fitted with an attachment for driving all drum rivets including manhole and blank heads, the boring mill on page 21 for accurately machine boring the drum ends, the drilling facilities on page 22, and the special bending roll illustrated on page 23 which is one of the largest tools of its kind in any boiler shop.

The UNION IRON WORKS builds boilers only and is accordingly able to offer the selection of an unusually wide range of auxiliary equipment best suited to any particular operating condition or engineer's preference, which can be included in a unit contract with undivided responsibility.

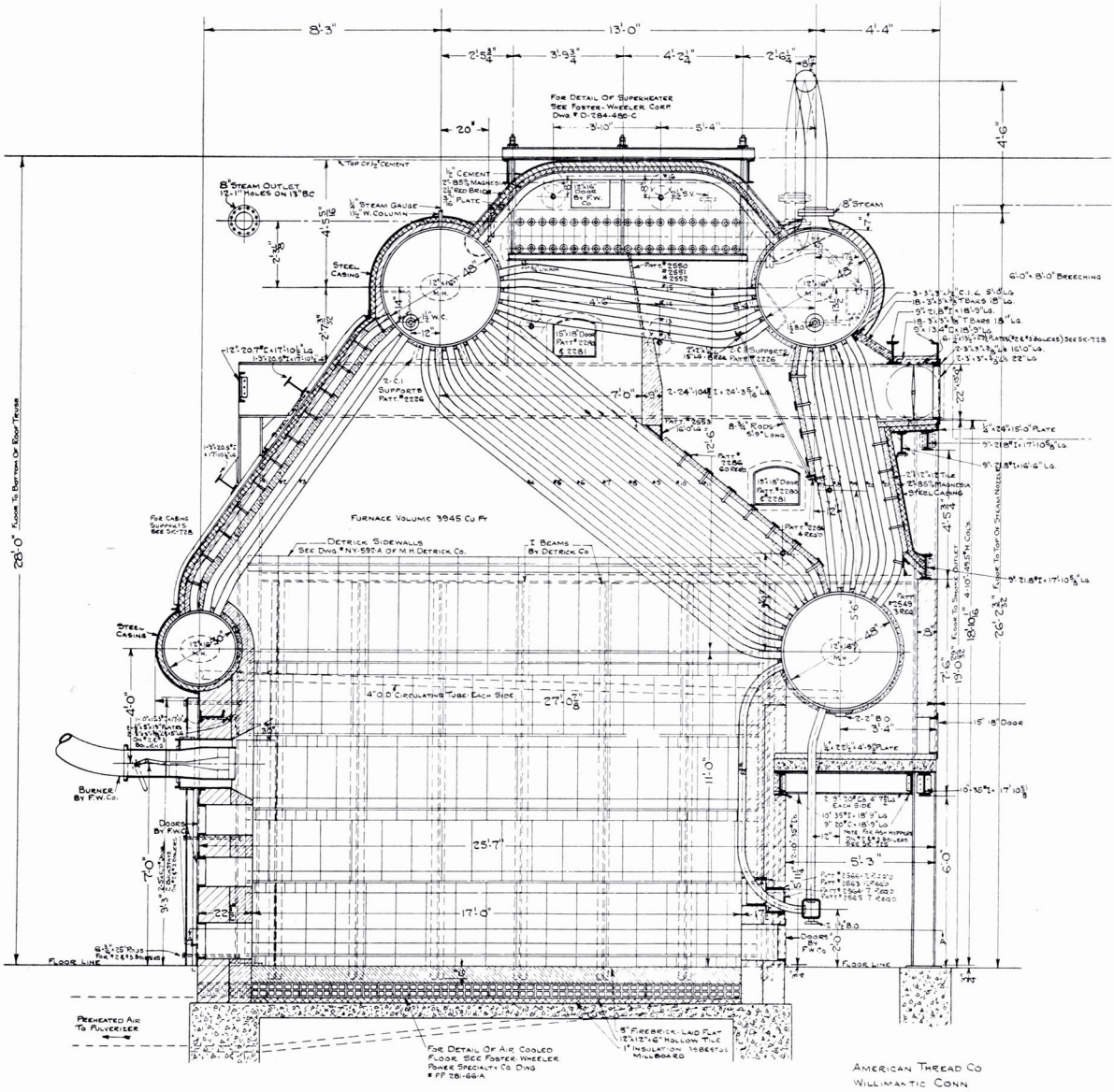
The UNION IRON WORKS is prepared to enter into complete contracts for the installation of steam plants with all accessories including settings, firing equipment, etc. Our engineering staff will gladly furnish surveys and proposals upon request.



518 H. P. N-A Type Boiler Arranged For Oil Burning

Built for P. J. Ritter Co., Bridgeton, New Jersey

This installation is designed for high overload capacities encountered in canning factory service and has carried peak ratings of 500%. The setting is equipped with air cooled side walls and a water cooled bridge wall.

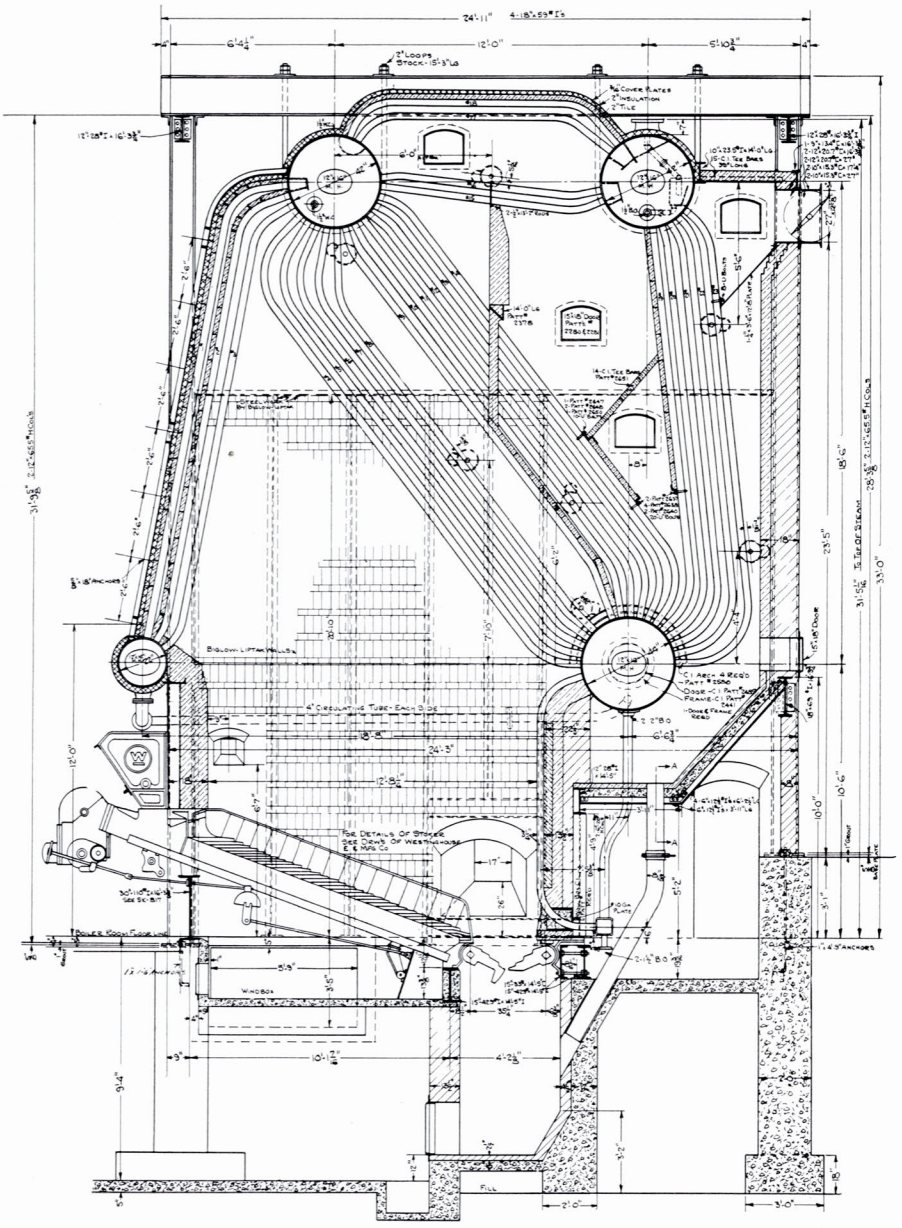


THREE N-A TYPE BOILERS OF SPECIAL LOW-HEAD ROOM DESIGN

Installed for the American Thread Company, Willimantic, Connecticut

These UNION N-Type Boilers, rated at 657 H. P. each and built for 225 lbs. working pressure, replaced eighteen boilers of another type. Complete installation was made by the UNION IRON WORKS, including boilers, pulverizers, superheaters, soot blowers and air cooled settings without interfering with plant operation. Service records from this plant show 498° F exit gas temperature and .18″ draft loss when operating at 200% of rating, 14% CO^2 and 210 lbs. pressure.

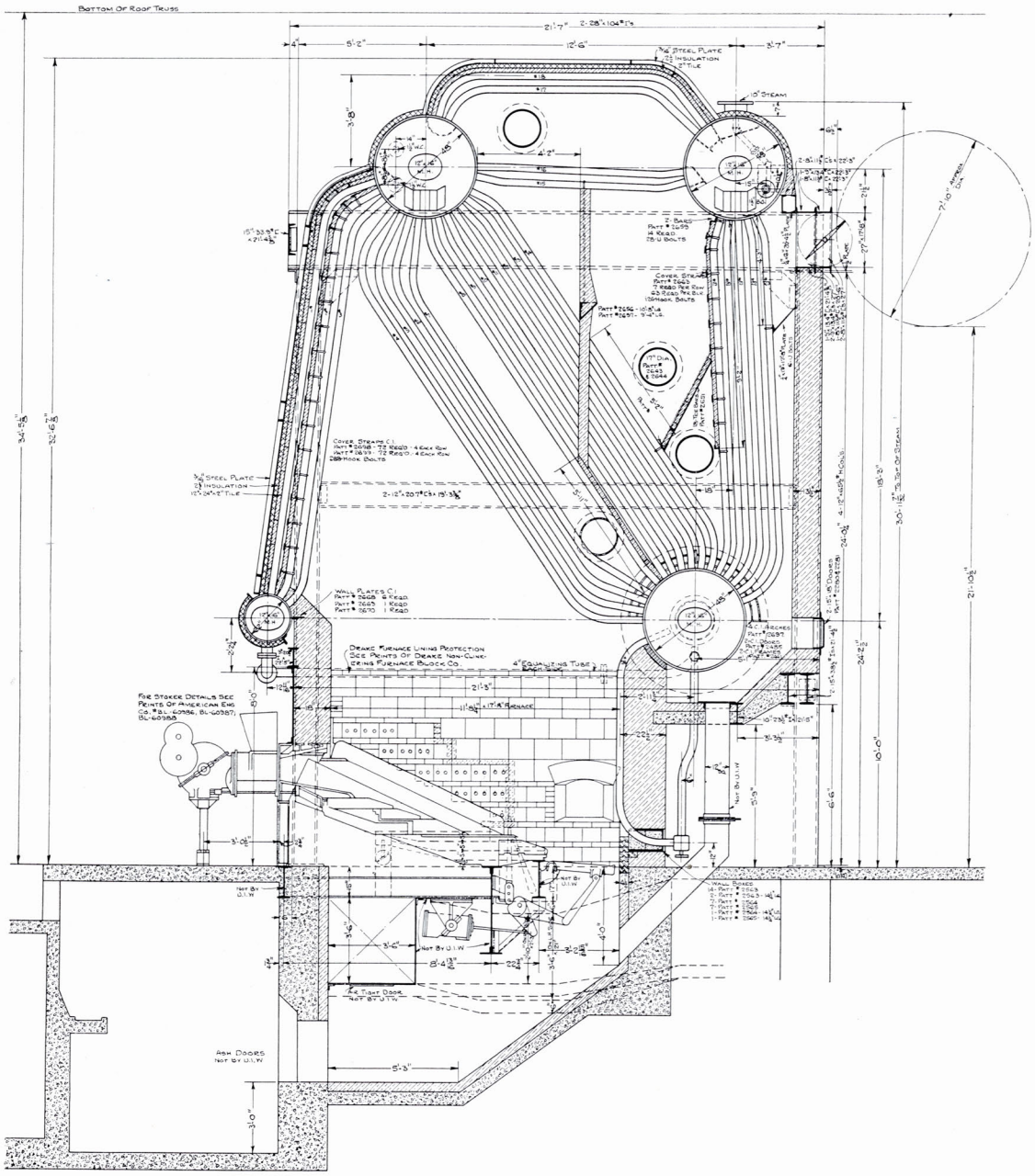
These boilers carry normal ratings in excess of 250% and have operated at 350% peaks.



N-A TYPE BOILER 754 H. P. AND 250 LBS. WORKING PRESSURE

Built for J. L. Stifel and Sons Co., Wheeling, West Virginia

THIS unit is operating at continuous ratings in excess of 300%, with peak loads of 350%. It has replaced four 300 H. P. and two 500 H. P. water tube boilers with considerable gains in economy and lower operating costs. The setting is an excellent example of the simplicity of the patented Front Radiant Heat Element and the absence of front wall or arch construction. With the addition of the bridge wall cooling it is particularly well adapted to high continuous ratings with a minimum of furnace maintenance.

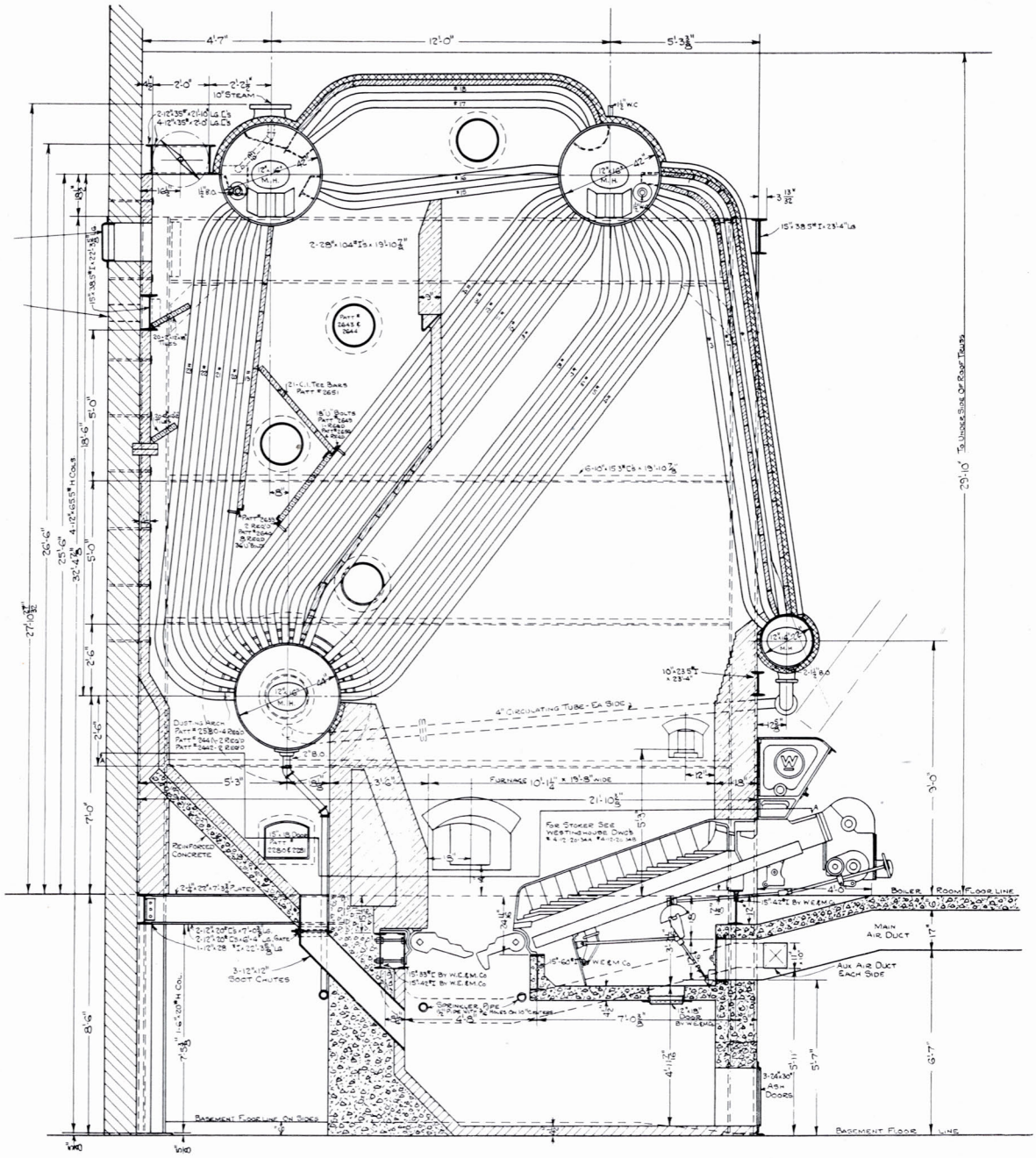


N-A Type Boiler 988 H. P. and 250 Lbs. Working Pressure

Installed for the Continental Rubber Works, Erie, Pennsylvania

This unit carries the entire load of a large rubber goods manufacturer and is designed for 250% continuous operation with 300% sustained peak loads. The setting has air-cooled side walls with water-cooled bridge wall and is fired with a multiple retort under feed stoker.

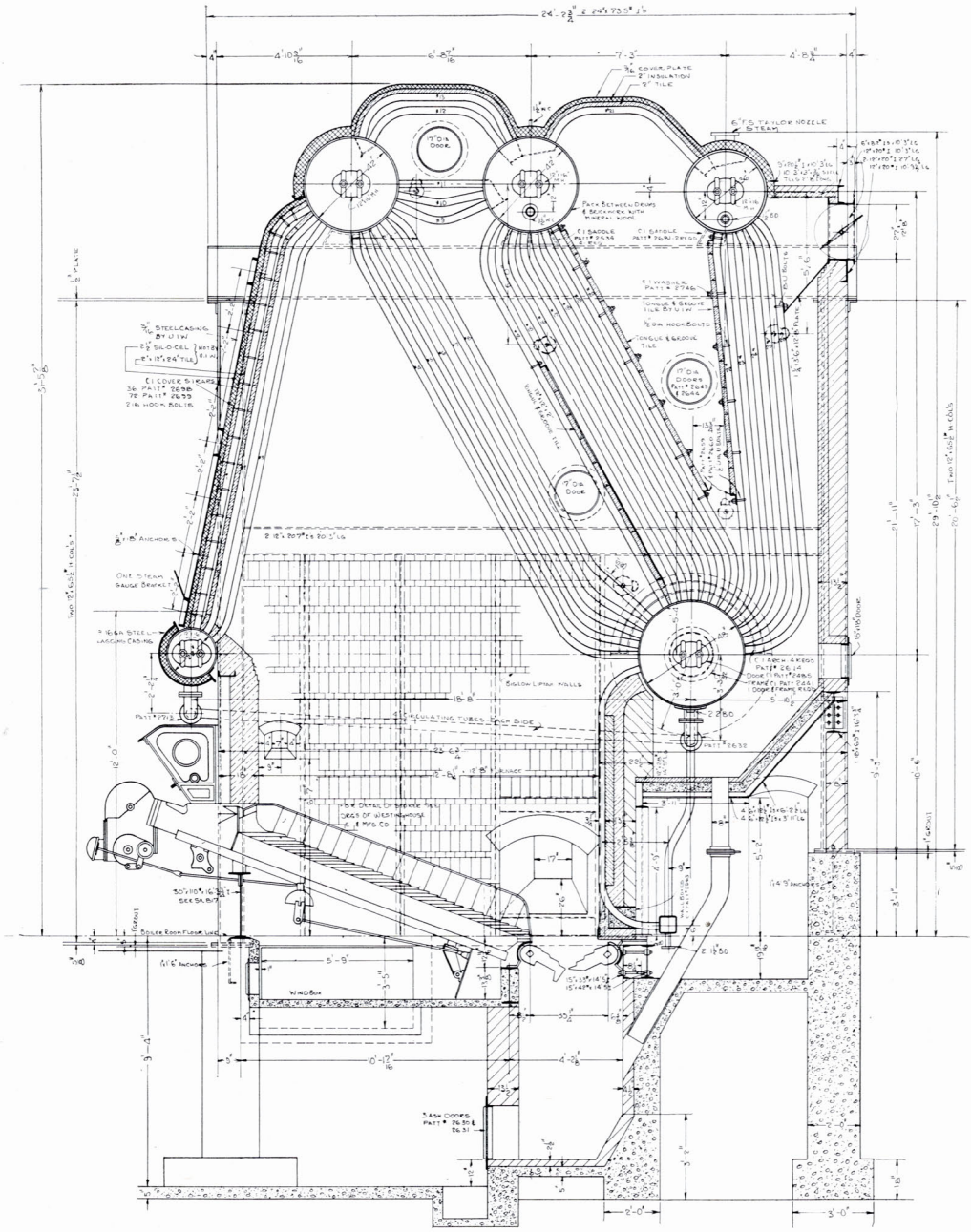
Test data given on page 19 shown 80.61% efficiency and a low draft loss of 0.144″ at 204.5% of rating and 13.84% CO^2.



N-A TYPE BOILER RATED AT 1170 H. P.

Operated by the Lovell Manufacturing Company of Erie, Pennsylvania

THIS setting is a typical design of a large industrial installation built for high boiler capacity. The complete installation including the boiler, stoker, soot blower, breeching and removal of old equipment was executed by the UNION IRON WORKS in one blanket contract.



UNION N-B TYPE BOILER

THIS design is generally similar to that of the N-A Type Boiler, having an additional integral economizer section. It is also built as a four drum boiler without the Front Radiant Heat Element.

The position of the lower front drum can be changed either horizontally or vertically to suit firing conditions, available space and furnace volume required.

The bridge wall cooling adds to boiler capacity and protects the bridge wall refractory.

UNION IRON WORKS
ERIE, PENNA.

TEST No. 5-5-30

DATA AND RESULTS OF BOILER TEST

Name of plant: Continental Rubber Works
Location: Erie, Pa.
Type of Boiler: Union N-A — No. of passes: 3
Height of setting: 10'-0" — Extension:
Kind of fuel: Pittsburgh Slack — Where mined:
Type of stoker: American Engineering Co. "Taylor"
Grate surface: 205 sq. ft. — Water heating surface: 9880

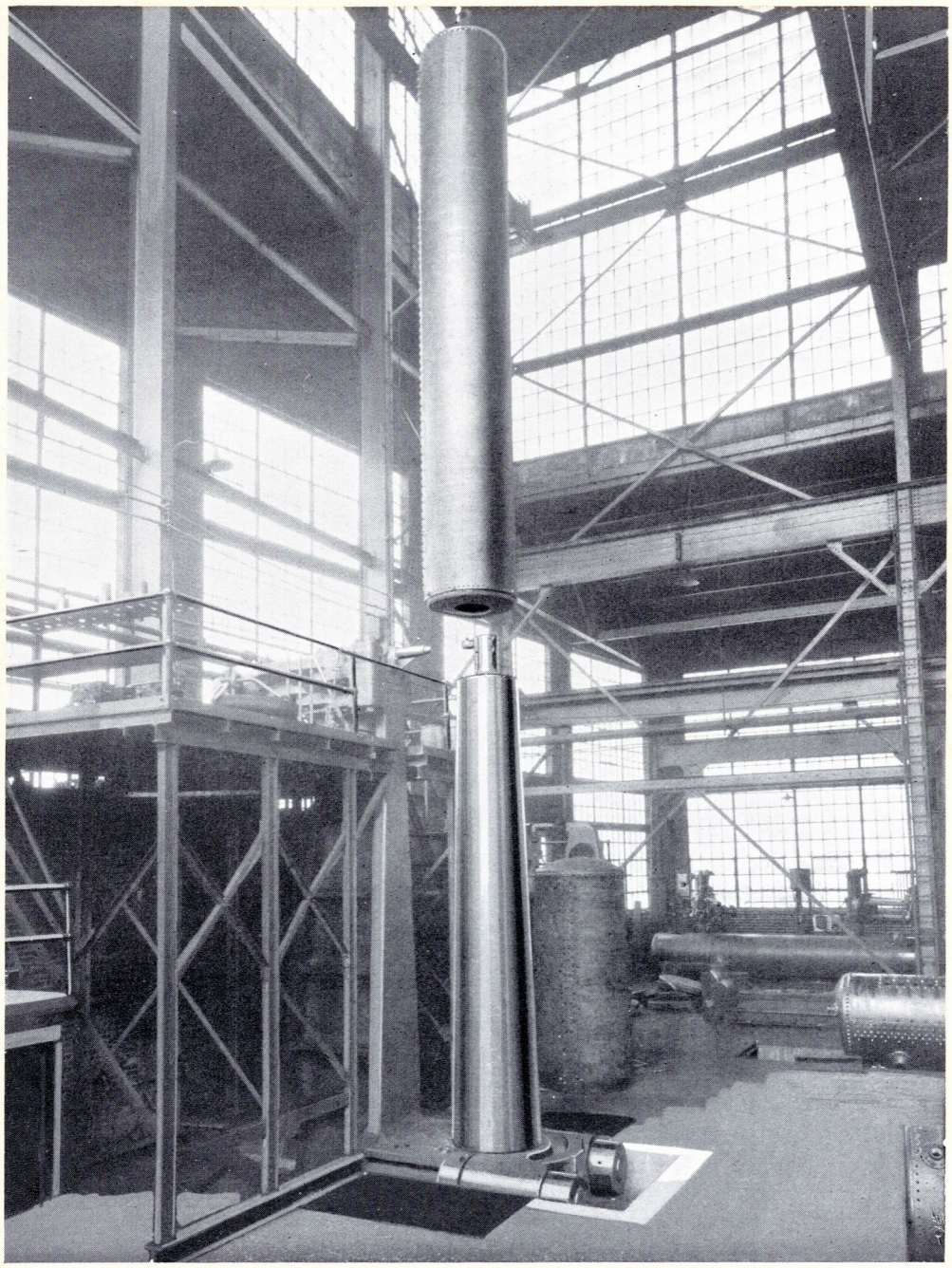
Tubes high: 10
Furnace width: 17'-8"
Size:
Size:
Ratio: 1:48

Approved by: M. E. Smith

Bedo, Roberts, Smith
Test Engineers

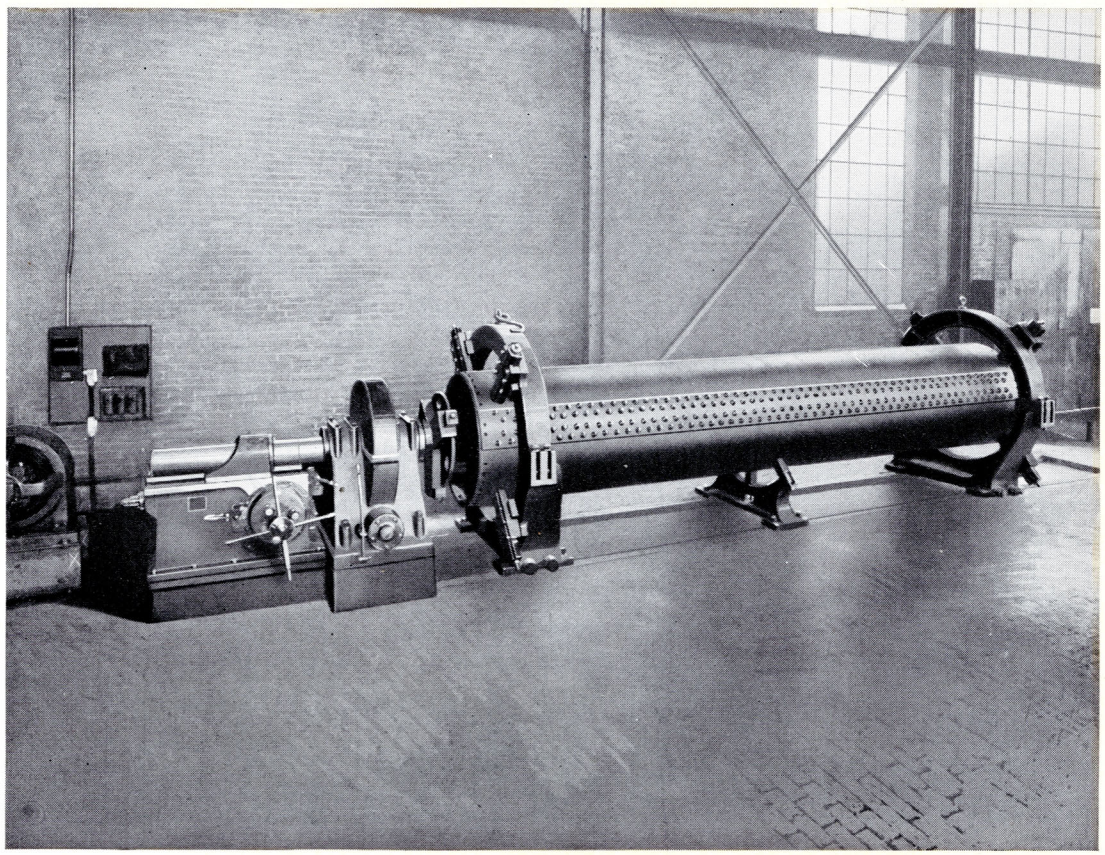
Total Quantities		
1.	Date of test	5-5-30
2.	Duration of test	8 Hours
3.	Weight of coal as fired	53041
4.	Total weight of dry coal	51216
5.	Total ash and refuse (dry)	5170
6.	Percentage of ash and refuse based on dry coal	10.0
7.	Percentage of moisture in steam or degrees of super-heating	0.6
8.	Total weight of water fed to the boiler	538368
9.	Water actually evaporated	535138
10.	Factor of evaporation	1.042
11.	Equivalent water evaporated into dry steam from and at 212°	557614
Hourly Quantities		
12.	Coal per hour as fired	6630.1
13.	Dry coal per hour	6453.0
14.	Dry coal per sq. ft. of grate surface per hour	31.4
15.	Dry Steam Evaporated	66892.2
16.	Equivalent evaporation per hour from and at 212°	69702.0
17.	Equivalent evaporation per hour from and at 212° per sq. ft. water heating surface	7.05
Average Pressure, Temperatures, Etc.		
18.	Steam pressure by gauge (corrected)	124.3
19.	Temperature of feed water entering boiler	213.0
20	Temperature of steam	352.5
21.	Temperature of escaping gases from boiler	559.5
22.	Air pressure under fuel bed	+ 2.39
23.	Draft boiler side of damper	− 0.229
24.	Draft in furnace	− 0.085
25.	Draft Loss, Furnace to Damper	− 0.144
26.	Temperature of air entering furnace	90.3
Horse Power		
27.	Horse power developed	2020.3
28.	Builders' rated horse power	988.0
29.	Percentage of builders' rated horse power developed	204.5
Economic Results		
30.	Water evaporated under actual conditions per lb. of coal as fired	10.09
31.	Equivalent evaporation from and at 212° per lb. of coal as fired	10.51
32.	Equivalent evaporation from and at 212° per lb. of dry coal	10.80
33.	Efficiency of boiler, furnace and grate	80.61

Fuel Analysis—Proximate		
34.	Mois. (as received)	2.37
35.	Vol. (dry)	31.13
36.	F. C. (dry)	57.56
37.	Ash. (dry)	11.31
38.	Sul. (dry)	2.99
39.	B. t. u. (as fired)	12692
40.	B. t. u. (dry)	13000
Ultimate		
41.	C.	65.81
42.	H.	4.63
43.	N.	1.35
45.	O.	9.95
46.	S.	3.69
47.	Ash.	14.57
Ash Analysis		
48.	Combustible %	36.9
49.	Ash per hour	
50.	Fusing Temp.	
Gas Analysis		
51.	CO_2	13.84
52.	O_2	5.20
53.	CO	.02
54.	N. (by diff.)	80.94



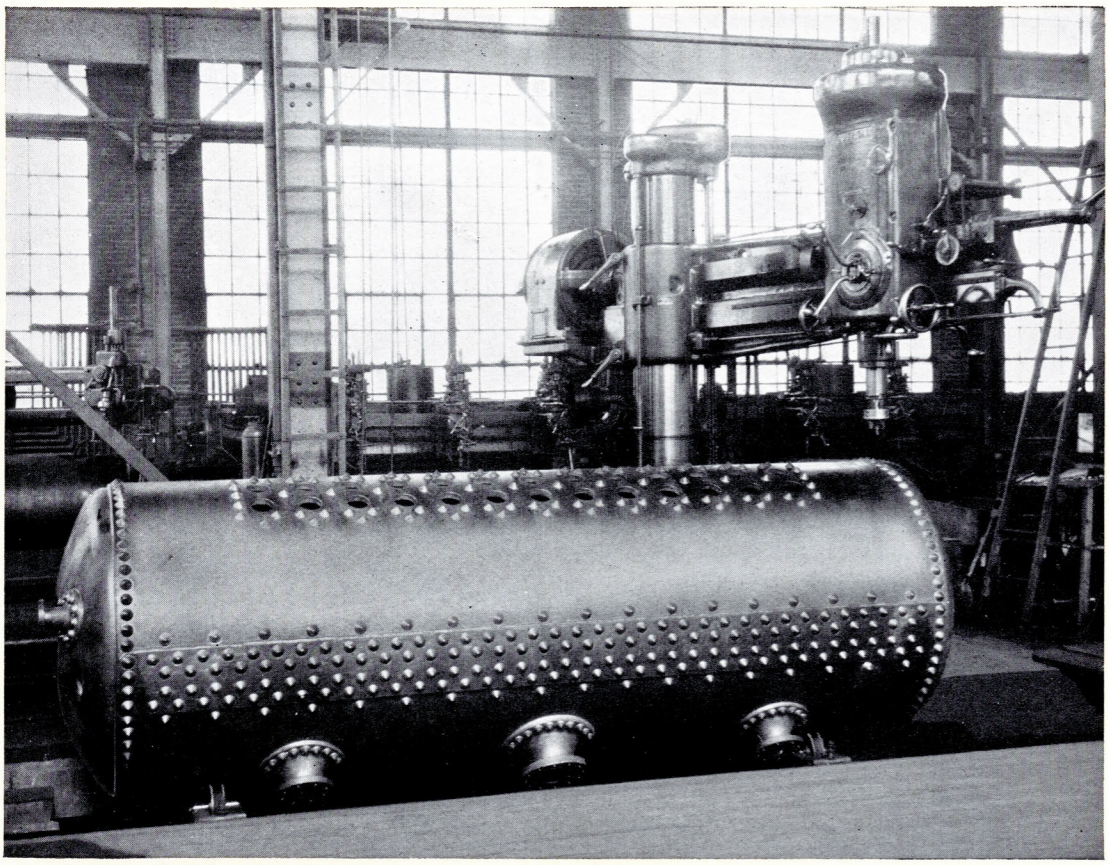
HYDRAULIC RIVETERS

HYDRAULIC riveters ranging in capacity from fifty to two hundred tons, served by independent overhead cranes which can turn a forty-foot cylindrical shell over the stake of the largest riveter. The large riveter shown in the center has an eighteen foot six inch forged steel stake, fitted with a detachable head which makes it possible to drive all rivets for both manhole heads and blank heads by hydraulic pressure. All rivets are heated in a special non-oxidizing electric hearth furnace. They are free from scale and heated to a controlled uniform temperature.



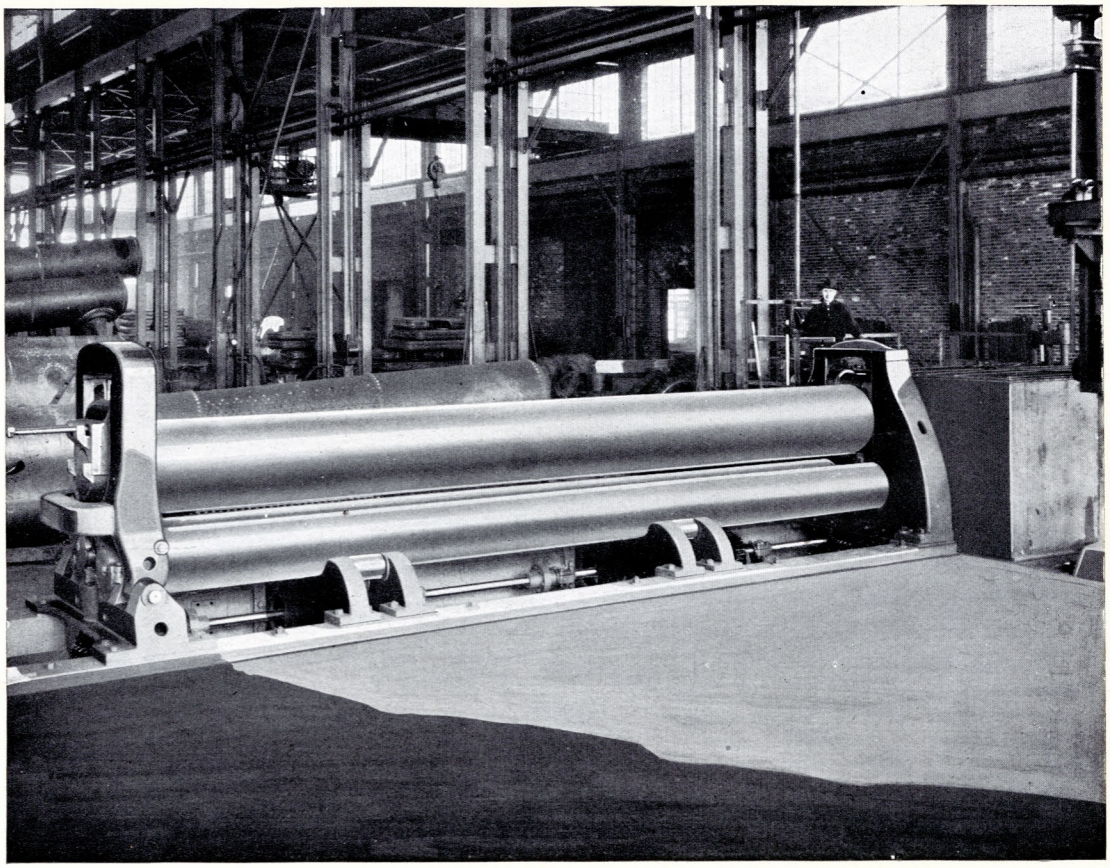
BORING MILL OF SPECIAL DESIGN FOR HIGH PRESSURE BOILER WORK

THIS mill machines the inside surface of the drums to insure accurate fitting of the drum heads. The heads are also machine turned to close tolerances.



RADIAL DRILL

THIS large radial drill is one of a battery used for cutting all tube holes and rivet holes in the drums. Special equipment is used to rotate the drums and to move them laterally, insuring accurate drilling of all holes in one set-up.



BENDING ROLL

THIS large bending roll, forty-five feet long over all is capable of rolling heavy plate in lengths that permit us to fabricate all boiler drums in one piece. This is one of the largest bending rolls used in any boiler shop.

DISTRICT REPRESENTATIVES

BALTIMORE, MD.	ED. L. STOCK, INC.	502 St. Paul Street
BUFFALO, N. Y.	J. H. ROSEBERRY	1211 Genesee Bldg.
CHICAGO, ILL.	C. B. ADAMS & CO.	333 N. Michigan Blvd.
CLEVELAND, OHIO	THE EUGENE SMITH CO.	Rockefeller Bldg.
DENVER, COLO.	W. V. FEATHERLY	517 Cooper Bldg.
DETROIT, MICH.	W. HAWLEY & CO.	6032 Fort St., W.
EL PASO, TEXAS	R. E. HUTHSTEINER	615 Mills Bldg.
HOUSTON, TEXAS	M. N. DANNENBAUM CO.,	710 Banker's Mortgage Bldg.
LOS ANGELES, CAL.	SEWARD RICE	401 Bradbury Bldg.
NEW YORK, N. Y.	JOSEPH LAPPIN, INC.	1819 Broadway
PHILADELPHIA, PA.	WALTER H. WILD, INC.	1015 Land Title Bldg.
PITTSBURGH, PA.	JAMES T. CASTLE	424 First Avenue
RICHMOND, VA.	SHULTZ & JAMES, INC.	7 North 6th Street
SALT LAKE CITY, UTAH,	F. C. RICHMOND MACHINERY CO.	
SAN FRANCISCO, CAL.	KING-KNIGHT CO.	Balboa Bldg.
SEATTLE, WASH.	KING-KNIGHT CO.	64 Marion Street
SHERMAN, TEXAS	HARDWICKE-ETTER CO.	
ST. LOUIS, MO.	J. RUSSELL BLEY	1122 Syndicate Trust Bldg.
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WASHINGTON, D. C.	ED. L. STOCK, INC.	1117—15th St., N. W.

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